

**Rapid Communication****The alien fissurellid *Diodora ruppellii* (G. B. Sowerby I, 1835): a first record for Libya from Tripoli Harbour**Jamila Rizgalla^{1,*}, Andrew P. Shinn^{2,3} and Fabio Crocetta⁴¹Department of Aquaculture, Faculty of Agriculture, University of Tripoli, Tripoli, Libya²Institute of Aquaculture, University of Stirling, UK³Fish Vet Group Asia Limited, Saensook, Chonburi, 20130, Thailand⁴Department of Integrative Marine Ecology, Stazione Zoologica Anton Dohrn, Villa Comunale, I-80121 Napoli, ItalyAuthor e-mails: jamilarizgalla@gmail.com (JR), andy.shinn@fishvetgroup.com (APS), fabio.crocetta@szn.it (FC)

*Corresponding author

Citation: Rizgalla J, Shinn AP, Crocetta F (2019) The alien fissurellid *Diodora ruppellii* (G. B. Sowerby I, 1835): a first record for Libya from Tripoli Harbour. *BioInvasions Records* 8(4): 813–817, <https://doi.org/10.3391/bir.2019.8.4.09>

Received: 9 July 2019**Accepted:** 7 August 2019**Published:** 25 October 2019**Handling editor:** Karolina Bącela-Spychalska**Thematic editor:** Amy Fowler**Copyright:** © Rizgalla et al.This is an open access article distributed under terms of the Creative Commons Attribution License ([Attribution 4.0 International - CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)).**OPEN ACCESS****Abstract**

The mollusc *Diodora ruppellii* (G. B. Sowerby I, 1835) (Gastropoda: Lepetellida: Fissurellidae) is reported here for the first time as an alien species in Libyan coastal waters. Field surveys conducted throughout the winter period of 2018–2019 along the sandy shoreline bordering Tripoli Harbour yielded fourteen empty shells and one live specimen, all found within accumulating shell middens. While the finding of *D. ruppellii* in close proximity to Tripoli Harbour may allude to its introduction via shipping traffic, natural dispersal from nearby, known or yet undiscovered, Mediterranean populations cannot be ruled out. The current study forms part of a larger ongoing programme investigating the marine fauna of the littoral zone with a focus on the identification of non-native species. As *D. ruppellii* is so far recorded from Libya as based on the present punctiform record, we rank it here as a casual (i.e. not established) species in the country.

Key words: Mediterranean Sea, bioinvasions, alien spread, Mollusca, Fissurellidae**Introduction**

Alien species are frequently reported within harbours and marinas, their translocation assisted via their attachment to the hulls of shipping vessels or within ballast water (e.g. Lambert and Lambert 1998; Ulman et al. 2017; Zenetos et al. 2017; Sghaier et al. 2019). Introduced species are often successful in these sheltered and nutrient-rich environments with intense shipping activity, or in regions in close proximity to such, and can spread quickly, leading to arguably higher rates of being detected (see Rizgalla et al. 2018, 2019a, b; Sghaier et al. 2019, among recent references from the Mediterranean Sea). Among the alien species invading the Mediterranean Sea, the fissurellid mollusc *Diodora ruppellii* (G. B. Sowerby I, 1835) is a species that can be easily found in the shallow waters of marinas (Sghaier et al. 2019). This taxon, while native to the Indo-Pacific, has presumably entered the Mediterranean Sea through the Suez Canal (Zenetos et al. 2004), invading the eastern parts of the basin; published records of its occurrence

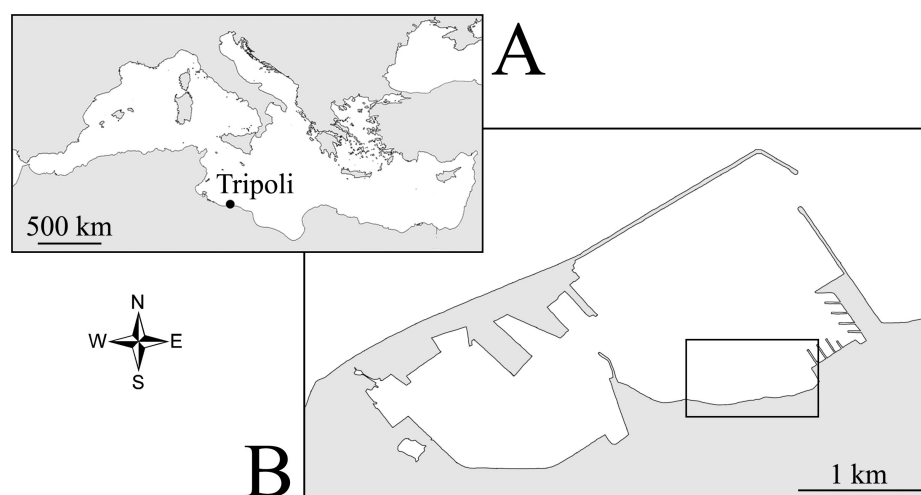


Figure 1. Study area. A. The location of Tripoli in the Mediterranean Sea. B. The Tripoli Harbour (inner and outer basins). The black rectangle highlights the sandy shore of the outer basin where *Diodora ruppellii* was found.

include Palestine, Egypt, Israel, Syria, Turkey and Lebanon (e.g. Haas 1948; Barash and Danin 1977, 1992; Engl 1995; Ammar 2004; Saker et al. 2013; Mytilineou et al. 2016; Crocetta et al. 2019 – but see below for a discussion on some of these sightings). More recently, a report published by Ounifi-Ben Amor et al. (2016) from Tunisia suggested that this species may have also spread from central parts of the Mediterranean basin. *Diodora ruppellii* is generally known to feed on sponges and, although it is generally considered to be a shallow water species, it can be found in waters of up to 70 m depth (Zenetos et al. 2004; Wronski 2010). Within the framework of an ongoing programme investigating alien species occurring in the marine coastal waters of Libya, here we provide the first record of *D. ruppellii* from Tripoli Harbour, in the central Mediterranean Sea.

Materials and methods

Tripoli Harbour is an old port with a long history dating back to the Phoenicians. In more modern times, its congestion has been well noted with up to 600 large vessels (i.e. up to 190 m long) visiting the port each year until the end of 2011. The harbour, with its cosmopolitan nautical activity, measures approximately 3.95 km long and almost 2 km broad at its widest point, covers an area of approximately 300 hectares, and is protected by two breakwaters, creating an outer and inner basin that are subject to tidal movements (World Port Source 2019; Mehdi Nailay *pers. comm.*). Weather permitting, daily surveys were undertaken from the 22nd November 2018 until the 28th January 2019 by walking approximately 600 to 800 m along the shoreline of mixed sandy, rocky, and pebbly substrates marking the outer harbour (32.901140°; 13.212579°; Figure 1). Beached material in the accumulating shell middens was sorted through by hand, and, when appropriate, specimens were photographed *in situ* using a Hawawei Honor mobile phone and an Olympus Tough camera. Empty shells

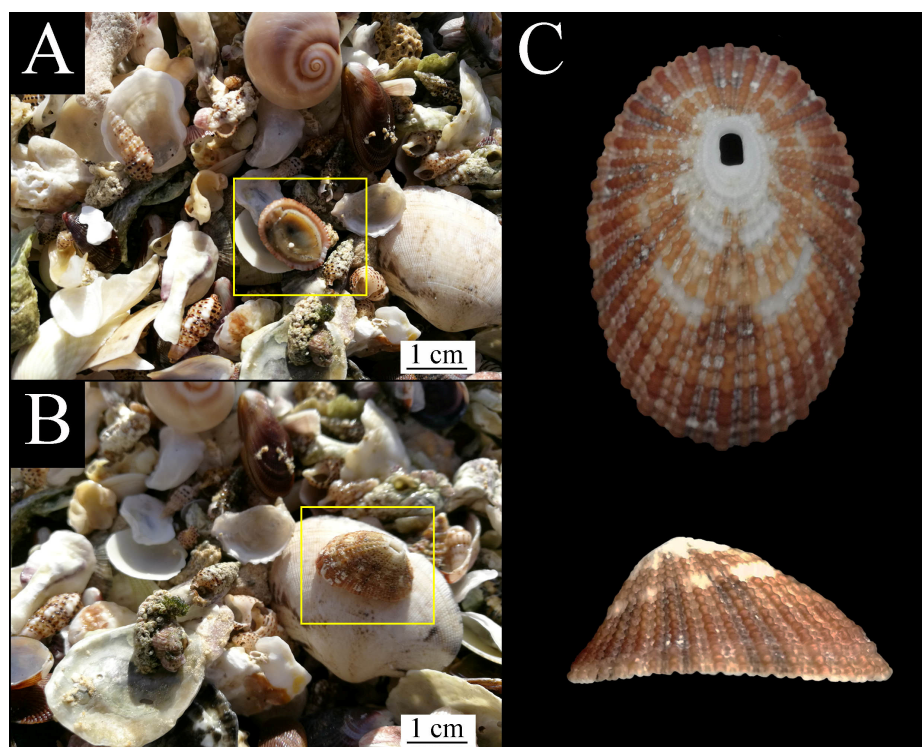


Figure 2. *Diodora ruppellii* from Tripoli Harbour, Libya. A–B. Ventral and dorsal (aperture) views of a stranded specimen with soft parts, highlighted by a yellow rectangle. C. Dorsal (aperture) view of a fresh empty shell (2.1×1.5 cm). Photographs by Jamila Rizgalla (A, B) and Fabio Crocetta (C).

were placed into labelled cardboard containers, while live specimens were fixed in 90% ethanol. All the collected material is held in a private archive maintained by the principal author and is available upon request.

Results

Fourteen empty shells of *D. ruppellii* were recovered from shell middens high on the foreshore. In addition, a single live specimen of *D. ruppellii* was found on the 7th January 2019, at low tide following a period of rough seas (Figure 2). In addition to the specimens of *D. ruppellii*, several other non-native molluscs were collected including live specimens and empty shells of *Cerithium scabridum* Philippi, 1848 (Gastropoda: Cerithiidae), *Brachidontes pharaonis* (P. Fischer, 1870) (Bivalvia: Mytilidae), and *Pinctada imbricata radiata* (Leach, 1814) (Bivalvia: Pteriidae).

Discussion

The geographic spread of *D. ruppellii* within the Mediterranean Sea, at least since 1939, accounts for multiple records of its occurrence throughout the basin, supporting the proposal that this is an established species in the region (Zenetos et al. 2017). For some of the published records though, only the name of the species appears, and in the absence of a detailed description and/or photographic evidence upon which to authenticate the occurrence, these records should be considered cautiously (see Ammar

2004; Saker et al. 2013). This is also the case for the only report of *D. ruppellii* from the central Mediterranean Sea, which is based on a personal communication (Ounifi-Ben Amor et al. 2016). The current report of *D. ruppellii*, therefore, not only represents the first record of this taxon in Libya, thus filling a distributional gap in the area now occupied by this mollusc, but also the westernmost confirmed occurrence of this species in the Mediterranean Sea.

The finding of *D. ruppellii* in Tripoli Harbour adds to the list of non-native species already encountered in the area (reported in Rizgalla et al. 2018, 2019a, b, c) and highlights the port as a hub for alien species. While the volume of nautical traffic moving in and out of the port may facilitate or increase the probability of introductions and establishment of species in Libya, the majority of the alien species found so far are already known to have widespread distributions throughout the Mediterranean Sea, and so natural dispersal from neighbouring populations for *D. ruppellii* and the other taxa encountered cannot be ruled out (Rizgalla et al. 2018, 2019a, b, c). Events in Libya's recent past have made the undertaking of comprehensive surveys difficult to almost impossible; the lack of field surveys, therefore, makes it impossible to comment on whether the introductions are recent or otherwise (see the discussions in Rizgalla et al. 2019a). It is possible, therefore, that *D. ruppellii* may have been present in Libyan waters for many years, at low abundances, but their occurrence only came to light following the start of the current survey programme, increasing the level of surveillance for non-native species, and coupled with the winter-storms throughout 2018–2019 and the volume of material carried onto the foreshore. The combination of factors contributing to the “discovery” of non-native species was also discussed for the finding of the alien bivalve *Fulvia fragilis* (Forsskal in Niebuhr, 1775) in Libyan waters (see Rizgalla et al. 2019b).

While the documentation of non-native species is important, it is also critical that programmes of bio-surveillance continue to follow the fate of species following their arrival to determine if species can establish breeding populations. The successful colonisation of a species in a new locale may depend on various intrinsic and extrinsic factors, such as their response to local environmental conditions, food availability, and niche interactions with local species, etc. As *D. ruppellii* in the central Mediterranean is currently known with certainty only from Libya, and this is based on the present opportunistic record, we rank the species here as casual (i.e. not established, a species where only a single or few specimens had been recorded, with no certainties that it ever spread or reproduced in the area or the country). Through the ongoing survey programme, it is hoped that the status of *D. ruppellii* can be later confirmed as either an established or an ephemeral introduction.

Acknowledgements

The authors wish to thank Mr. Mehdi Nailay and Mr. Adam Sahata for supplying information regarding the structure and function of the Tripoli Harbour. The authors wish also to thank the two anonymous reviewers for their insightful comments on the paper.

References

- Ammar I (2004) Benthic fauna of the Syrian coast - assessment of the state of migrant and invasive species. *Rapports et Procès-Verbaux des Réunions de la Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée* 37: 473
- Barash A, Danin Z (1977) Additions to the knowledge of Indo-Pacific Mollusca in the Mediterranean. *Conchiglie* 13: 85–116
- Barash A, Danin Z (1992) Fauna Palaestina. Mollusca I. Annotated List of Mediterranean Mollusca of Israel and Sinai. The Israel Academy of Sciences and Humanities, Jerusalem, 405 pp
- Crocetta F, Bitar G, Zibrowius H, Oliverio M (2019) Increase in knowledge of the marine gastropod fauna of Lebanon since the 19th century. *Bulletin of Marine Science* 96, <https://doi.org/10.5343/bms.2019.0012>
- Engl W (1995) Specie prevalentemente Lessepsiane attestate lungo le coste Turchie. *Bollettino Malacologico* 31: 43–50
- Haas G (1948) Sur l'immigration de mollusques Indo-Pacifiques dans les eaux côtière de la Palestine. *Journal de Conchyliologie* 88: 141–144
- Lambert CC, Lambert G (1998) Non-indigenous ascidians in southern California harbors and marinas. *Marine Biology* 130: 675–688, <https://doi.org/10.1007/s002270050289>
- Mytilineou Ch, Akel EHK, Babali N, Balistreri P, Bariche M, Boyaci YÖ, Cilenti L, Constantinou C, Crocetta F, Çelik M, Dereli H, Dounas C, Durucan F, Garrido A, Gerovasileiou V, Kapiris K, Kebapcioglu T, Kleitou P, Krystalas A, Lipej L, Maina I, Marakas P, Mavrič B, Moussa R, Peña-Rivas L, Poursanidis D, Renda W, Rizkalla SI, Rosso A, Scirocco T, Sciuto F, Servello G, Tiralongo F, Yapici S, Zenetos A (2016) New Mediterranean Biodiversity Records (November, 2016). *Mediterranean Marine Science* 17: 794–821, <https://doi.org/10.12681/mms.1976>
- Ounifi-Ben Amor K, Rifi M, Ghanem R, Zaouali J, Ben Souissi J (2016) Update of alien fauna and new records from Tunisian marine waters. *Mediterranean Marine Science* 17: 124–143, <https://doi.org/10.12681/mms.1371>
- Rizgalla J, Fridman S, Ben Abdallah A, Bron JE, Shinn AP (2018) First record of the non-native sea snail *Haminoea cyanomarginata* Heller & Thompson, 1983 (Gastropoda: Haminoeidae) in the Southern Mediterranean Sea. *BioInvasions Records* 7: 411–414, <https://doi.org/10.3391/bir.2018.7.4.09>
- Rizgalla J, Bron JE, Crocetta F, Shinn AP, Almabruk SAA (2019a) First record of *Aplysia dactylomela* Rang, 1828 (Mollusca: Gastropoda) in Libyan coastal waters. *BioInvasions Records* 1: 80–86, <https://doi.org/10.3391/bir.2019.8.1.08>
- Rizgalla J, Shinn AP, Crocetta F (2019b) First documented record of the invasive cockle *Fulvia fragilis* (Forsskal in Niebuhr, 1775) (Mollusca: Bivalvia: Cardiidae) in Libya. *BioInvasions Records* 8: 314–319, <https://doi.org/10.3391/bir.2019.8.2.13>
- Rizgalla J, Shinn AP, Crocetta F (2019c) New records of alien and cryptogenic marine bryozoan, mollusc, and tunicate species in Libya. *BioInvasions Records* 8: 590–597, <https://doi.org/10.3391/bir.2019.8.3.15>
- Saker F, Abbas G, Sabha A (2013) The specific composition of assemblages gastropods and economic migratory species in several locations of the Syrian coast. *Tishreen University Journal for Research and Scientific Studies - Biological Sciences Series* 35: 110–128
- Sghaier YR, Zakhama-Sraieb R, Ben Hmida A, Charfi F (2019) An inventory of non-indigenous species (NIS) inside and outside three tourist marinas from the southern Mediterranean coast. *Journal of the Black Sea/Mediterranean Environment* 25: 29–48
- Ulman A, Ferrario J, Occhpinti-Ambrogi A, Arvanitidis C, Band A, Bertolino M, Bogi C, Chatzigeorgiou G, Çiçek BA, Deidun A, Ramos-Espla A, Koçak C, Lorenti M, Martinez-Laiç G, Merlo G, Princisgh E, Scribano G, Marchini A (2017) A massive update of nonindigenous species records in Mediterranean marinas. *PeerJ* 5: E3954, <https://doi.org/10.7717/peerj.3954>
- World Port Source (2019) <http://www.worldportsource.com> (accessed 8 July 2019)
- Wronski T (2010) The molluscan bio-fouling community on the Red Sea pearl oyster beds (Mollusca: Pteriidae). *Zoology in the Middle East* 51: 67–73, <https://doi.org/10.1080/09397140.2010.10638442>
- Zenetos A, Gofas S, Russo G, Templado J (2004) CIESM Atlas of exotic species in the Mediterranean. Vol. 3. In: Briand F (ed), Molluscs. CIESM Publishers, Monaco, 380 pp
- Zenetos A, Çinar ME, Crocetta F, Golani D, Rosso A, Servello G, Shenkar N, Turon X, Verlaque M (2017) Uncertainties and validation of alien species catalogues: the Mediterranean as an example. *Estuarine, Coastal and Shelf Science* 191: 171–187, <https://doi.org/10.1016/j.ecss.2017.03.031>